# design ideas

*Edited by Bill Travis and Anne Watson Swager*

## Simple circuit prevents processor latch-up

*Michal Kobylecki and Wojda Wlodzimierz, MK Design, Warsaw, Poland*

The circuit in **Figure 1** uses a Dallas Semiconductor DS1820 one-wire digital thermometer in a multipoint temperature-measurement system. The DS1820 sensor allows distributed temperature measurement and uses only one wire for both data communication and the power supply. You can easily connect the one-wire interface to a µC (in this example, a PIC16C63). The application accommodates as many as 16 DS1820 sensors in a 100m-long network, dubbed MicroLAN by Dallas. Unfortunately, with such long wires near high-current power cables, inductively coupled high-voltage peaks can cause µC latch-up, because the transient-voltage suppressor, $D_1$, cannot limit the line voltage below 9.8V. The interface circuit in **Figure 1** prevents such faults.

The sensor needs only one data line, but the interface circuit in **Figure 1** needs two CPU-control signals. The first is the inverted-output data line, connected to transistor $Q_1$ through resistor $R_3$. If this line is at logic 1, the sensor's data line connects to ground. Otherwise, resistor $R_4$ pulls the sensor's data line to 5V. If the sensor transmits data, the µC captures the data via $R_2$. If an overvoltage peak occurs, $R_2$ prevents µC latch-up by limiting the current to the µC pin. During the temperature conversion, the DS1820 needs an effective pullup circuit to provide an accurate conversion. Transistors $Q_1$, $Q_2$, and $R_1$ provide an effective pullup function, which the µC activates by grounding the input signal to $Q_3$.

The pullup function also improves the rising edge of the transmitted data. If the sensor connects to the µC through a long wire, the capacitance of the line degrades the rising edge of the data signals, because of the line-capacitance-$R_4$ time constant. The short pulse from the pullup circuit improves the signal's rising edge. It's obvious that, when the pullup circuit turns on, $Q_3$ must be off. However, the circuit protects itself against unintended signal corruption. If $Q_3$ is open, the power voltage does not connect to the sensor's data line. If you replace $R_4$ with a 1-mA current source, you can obtain effective data transmission with lengths as great as 500m (empirically verified). (DI #2317).

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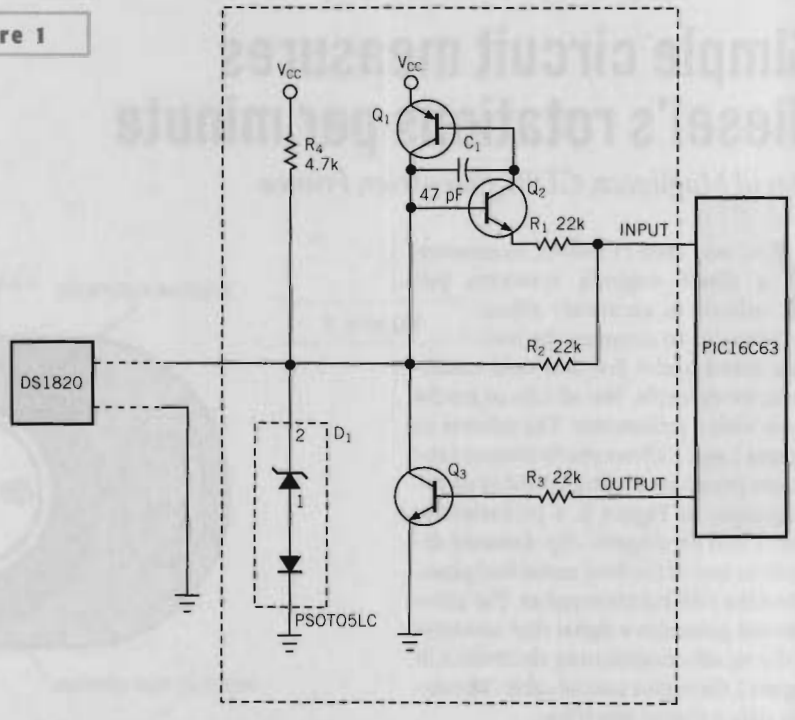
Figure 1




**A simple three-transistor circuit provide both latch-up protection and signal conditioning in this one-wire sensor/µC interface.**

# Dual one-shot makes rising- and falling-edge detector

*Santo Camonita, Catania, Italy*

THE DESIGN IN **Figure 1** is an upgraded version of the circuit in a previous Design Idea ("Edge detector runs off single supply," *EDN*, Dec 4, 1997, pg 140). It has fewer components, draws less current, and has higher input impedance. The circuit uses a 4098 dual monostable multivibrator with both sections connected. The circuit generates a pulse on both the rising and the falling edges of a signal. The duration of the output pulse is $T=0.5R_2C_2$. $R_1$ and $C_1$ provide power-on reset. The circuit has another advantage: It provides two independent true outputs (Q1, Pin 6 and Q2, Pin 10) and two independent complementary outputs ($\overline{Q1}$, Pin 7 and $\overline{Q2}$, Pin 9). (DI #2316).

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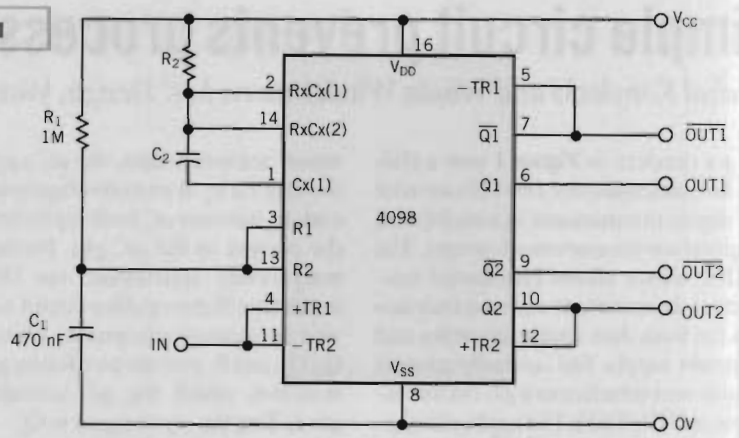
Figure 1




**A dual monostable multivibrator provides a convenient means of detecting a signal's rising and falling edges.**

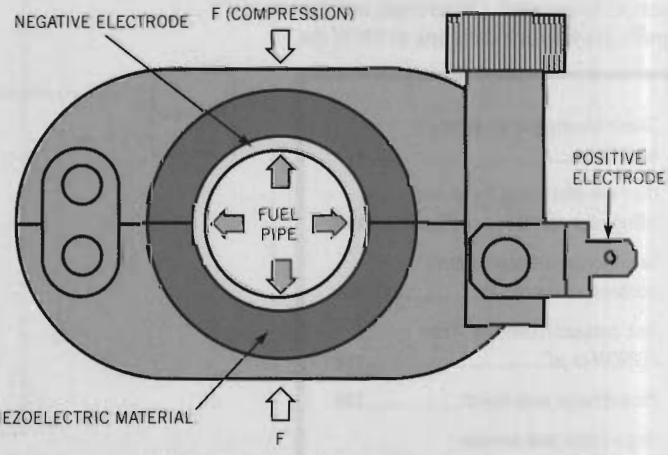
# Simple circuit measures diesel's rotations per minute

*David Magliocco, CDPI, Scientrier, France*

YOU MAY FIND IT USEFUL to measure a diesel engine's rotations per minute to accurately adjust the idling or to compare the motor's speed under hot and cold conditions, for example. Not all cars or trucks come with a tachometer. The scheme in **figures 1** and **2** allows you to measure rotations per minute with a DMM or an oscilloscope. In **Figure 1**, a piezoelectric sensor and an alligator clip, fastened directly to one of the four metal fuel pipes, detect the fuel-injection pulses. The piezo element generates a signal that connects to the signal-conditioning electronics in **Figure 2** through a coaxial cable. The circuit uses a charge amplifier.

$IC_1$, a versatile ICL7611 chosen for its high input impedance, low bias current,

Figure 1

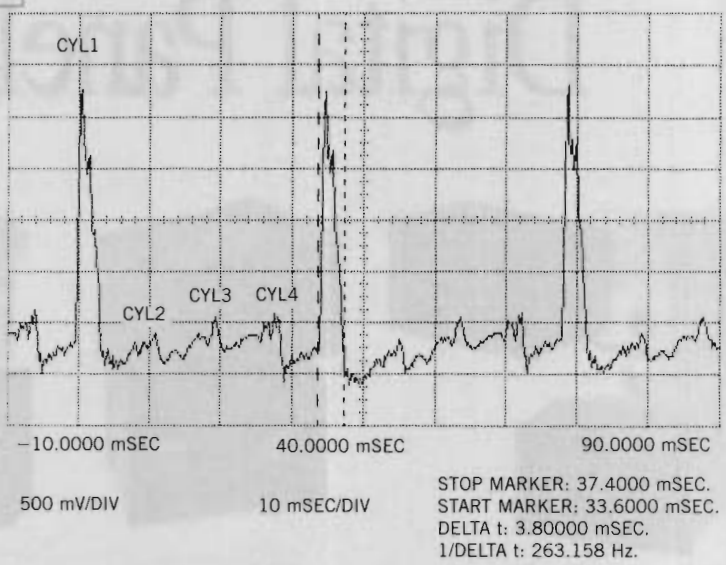



**A piezoelectric sensor and an alligator clip provide an easy means of measuring the rpm of a diesel engine.**

and reasonable power consumption, acts as an inverting current-to-voltage converter. $C_1$ integrates the high-dV/dt sensor signal. $R_1$ ensures that the output of $IC_2$ is high in the absence of a signal. You must use high values for $R_2$, $R_3$, and $R_4$. The two diodes at the input protect the amplifier against overvoltage spikes. $R_5$ and $R_6$ create a virtual ground, so the circuit uses the full common-mode input range of $IC_1$. **Figure 3** shows an oscilloscope trace of the amplifier's output. The three small peaks between the main pulses are parasitic and come from the injection pulses of the other cylinders. You can fine-tune the shape of the signal with $C_1$. A value near 1 nF yields a smooth signal with low amplitude; a value lower than 100 pF gives a noisy signal with narrow pulses. The value for the trace in **Figure 3** is 100 pF.

From one vehicle to another, the amplitude of the signal can vary over an approximately 2-to-1 ratio. You can't use a fixed threshold to shape the signal; either the threshold is too low, and you shape the parasitic pulses, or it's too high, and you obtain nothing. Thus, the signal-conditioning method compares the peak value to the average value: Only the main peaks are higher than the average value. $C_2$ and $R_7$ ignore the dc component of the charge amplifier's output signal, and transistors $Q_1$ and $Q_2$ charge $C_3$ to the peak value of that signal. You adjust $R_8$ and $R_9$ for a 90% ratio, which gives $IC_2$, a low-power CMOS comparator, a large enough signal to shape. $IC_2$ delivers a logiclike signal that you can measure with a DMM (using the frequency/period range, or the rotations-per-minute range on an automotive DMM), or with an oscilloscope. (DI #2318).

Figure 3




**After conditioning, the main peaks in the sensor signal come from the cylinder under test; the secondary peaks, from the other cylinders.**

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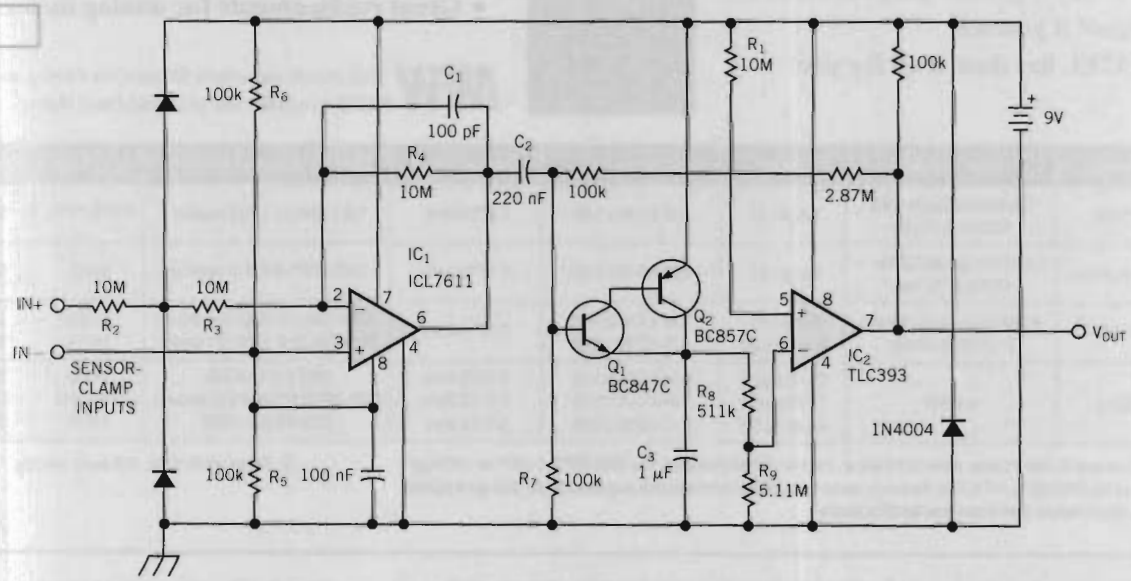
Figure 2




**A CMOS integrator and comparator condition the signal from Figure 1's sensor for interpretation by a DMM or an oscilloscope.**